

REMARKS

The timely filed Reply is responsive to the Office Action mailed September 12, 2005.

Claims 1-11 were pending at the time of the Office Action. All claims were rejected. Specifically, claims 1-11 were rejected as being anticipated by (i) U.S. Pat. No. 6,530,968 to Tsuchiya, (ii) U.S. Pat. No. 6,830,503 to Grumbine and (iii) U.S. Pat. No. 6,436,811 to Wake.

In the Reply, claims 1, 2, 4-6 have been amended and claim 10 has been cancelled. No new matter has been added.

Before reviewing the cited art, Applicants will first review the claimed invention as now recited in amended claim 1. Amended claim 1 recites a slurry for chemical mechanical polishing (CMP) of a metal comprising film, comprising a solution including:

at one halide ion, and

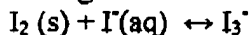
at least one diatomic halogen molecule selected from the group consisting of I_2 , Br_2 , Cl_2 and F_2 or interhalogen compound which comprise diatomic molecules which combine different halogen atoms.

The claimed slurry thus includes (i) at one halide ion, and (ii) at least one diatomic halogen molecule (I_2 , Br_2 , Cl_2 and F_2) or interhalogen compound (e.g. ICl , IBr). As noted in Applicants' specification, the halide ion can combine with halogen molecules in the slurry to form highly reactive polyhalide ions, such as I_3^- . Support for the amendment of claim 1 can be found throughout Applicants' specification, such as in paragraphs 15 and 16 (copied below):

[0015] As defined herein and generally recognized in solution chemistry and used in the application, the term "halogen" refers to a diatomic molecule, such as I_2 , Br_2 , Cl_2 , and F_2 . Halogens can be directly added to the slurry, or formed *in-situ* in the slurry. For examples, the addition of an oxidizer, such as hydrogen peroxide (H_2O_2) or potassium iodate (KIO_3), and iodide ions (I^-), can lead to the partial conversion of iodide ions into halogen iodine (I_2). The

halogens in the slurry may combine with halide ions to form polyhalide ions. Interhalogen compounds which combined different halogen, such as ICl, IBr, and others can also be used.

[0016] Halogens in solution produce characteristic colors to the solution, such as a purple color when Br₂ is present or varying from light yellow to deep yellow to black if iodine in different concentrations is present. The phrase "polyhalide ion" is also well defined in solution chemistry and as used herein refers to a molecular ion including at least two bound Group VIIA species, the species not necessarily being different, such as I₃⁻. Polyhalide ions are generally formed by mixing a halogen with a halide ion, such as:



Polyhalide ions can be contrasted with halide ions, which are also well defined and refer to monoatomic ions, such as F⁻, Cl⁻ and Br⁻. Halide ions, by themselves, are not known to impart color to a solution. Halide ions have reactivities quite distinct from polyhalide ions.

The claimed slurry forms a soft surface layer (e.g. copper iodide (CuI) or silver iodide (AgI)) on the metal being polished (soft as compared to the metal, such as Ag or Cu). This generally removes the need for conventionally required high concentrations of highly abrasive slurry particles, and as a result reduces dishing, erosion, surface scratching, peeling, and polishing of underlying layers during CMP. As noted in paragraphs 18 and 19 of Applicants' specification (copied below):

the invention substantially overcomes problems associated with CMP of most metal comprising layers commonly used in semiconductor fabrication. Specifically, the formation of a surface layer having a controlled hardness permits a reduction in dishing, erosion, surface scratching, peeling, and also a reduction in the polishing of underlying layers. In a preferred embodiment of the invention, the surface layer formed is a metal halide layer, such as copper iodide (CuI) or silver iodide (AgI).

As will be described below, although certain references appear to disclose a slurry including Applicants' claimed halide ion, no cited reference discloses or suggests a slurry including the claimed diatomic halogen molecule selected from the group consisting of I₂, Br₂, Cl₂ and F₂ or interhalogen compound which comprise diatomic molecules which combine different halogen atoms.

Tsuchiya discloses a chemical mechanical polishing slurry for polishing a metal film formed on an insulating film with a concave on a substrate wherein the slurry contains a thickener without an ionic group with an opposite sign to a charge on a polishing material surface to 0.001 wt % or more and less than 0.05 wt % to the total amount of the slurry and has a slurry viscosity of 1 mPa to 5 mPa both inclusive. The polishing slurry may be used in CMP to form a reliable damascene electric connection with excellent electric properties at a higher polishing rate, i.e., a higher throughput while preventing dishing or erosion.

Tsuchiya appears to disclose Applicants' claimed halide ion through the disclosure of cationic surfactants including CTAC and CTAB as cited by the Examiner. However, Tsuchiya does not disclose or suggest Applicants' claimed "diatomic halogen molecule selected from the group consisting of I₂, Br₂, Cl₂ and F₂ or interhalogen compound which comprise diatomic molecules which combine different halogen atoms". Although Tsuchiya mentions "halogens such as fluorine, chlorine, bromine and iodine, the "halogens" are disclosed as being bound substituents of generally aromatic molecules, such as the anti-oxidant benzotriazole as noted below (col. 6, lines 50-62; cited by the Examiner).

Examples of an antioxidant include benzotriazole, 1,2,4-triazole, benzofuroxane, 2,1,3-benzothiazole, o-phenylenediamine, m-phenylenediamine, catechol, o-aminophenol, 2-mercaptobenzothiazole, 2-mercaptobenzimidazole, 2-mercaptobenzoxazole, melamine and their derivatives. Among these, benzotriazole and its derivatives are preferable. Examples of a benzotriazole derivative include substituted benzotriazoles having a benzene ring substituted with hydroxy; alkoxy such as methoxy and ethoxy; amino; nitro; alkyl such as methyl, ethyl and butyl; halogen such as fluorine, chlorine, bromine and iodine. Examples of a 1,2,4-triazole derivative include a substituted 1,2,4-triazole having any of the substituents as described above in its 5-membered ring.

Fluorine, chlorine, bromine or iodine bound substituents of aromatic molecules are clearly not Applicants' claimed "diatomic halogen molecule selected from the group consisting of I₂, Br₂, Cl₂ and F₂ or interhalogen compound which comprise diatomic molecules which

combine different halogen atoms". Accordingly, Applicants submit that amended claim 1 and its respective dependent claims are patentable over Tsuchiya.

Grumbine discloses a method of polishing a substrate comprising (i) providing a substrate comprising an organic polymer film, (ii) contacting the substrate with a chemical-mechanical polishing system comprising a liquid carrier, an abrasive and/or polishing pad, a peroxy-type oxidizer, and a metal compound with two or more oxidation states, wherein the metal compound is soluble in the liquid carrier, and (iii) abrading at least a portion of the substrate to polish the substrate. Although Grumbine appears to disclose Applicant's claimed halide ion through disclosure of various metal halide species, Grumbine does not disclose or suggest Applicants' claimed slurry including at least on "diatomic halogen molecule selected from the group consisting of I_2 , Br_2 , Cl_2 and F_2 or interhalogen compound which comprise diatomic molecules which combine different halogen atoms". Accordingly, Applicants submit that amended claim 1 its respective dependent claims are patentable over Grumbine.

Wake discloses a process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a copper-containing metal film over the whole surface such that the concave is filled with the metal and then polishing the copper-containing metal film by chemical mechanical polishing, characterized in that the polishing step is conducted using a chemical mechanical polishing slurry comprising a polishing material, an oxidizing agent and an adhesion inhibitor preventing adhesion of a polishing product to a polishing pad, while contacting the polishing pad to a polished surface with a pressure of at least 27 kPa. This invention allows us to prevent adhesion of a polishing product to a polishing pad and to form a uniform interconnect layer with an improved throughput, even when polishing a large amount of copper-containing metal during a polishing

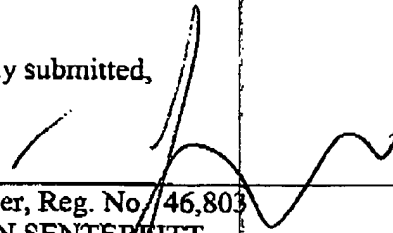
step. Wake and Tsuchiya are closely related applications having some common subject matter. Tsuchiya is a named inventor in Wake.

As with Tsuchiya, Wake appears to disclose Applicants' claimed halide ion through disclosure of ionic surfactants such as CTAC and CTAB. Although Wake mentions "halogens such as fluorine, chlorine, bromine and iodine", the halogens are disclosed as being bound substituents of generally aromatic molecules (such as benzotriazole BTA) as in Tsuchiya. As with Tsuchiya, Wake does not disclose or suggest Applicants' claimed slurry including at least on "diatomic halogen molecule selected from the group consisting of I₂, Br₂, Cl₂ and F₂ or interhalogen compound which comprise diatomic molecules which combine different halogen atoms". Accordingly, Applicants submit that amended claim 1 its respective dependent claims are patentable over Wake.

Applicants have made every effort to present claims which distinguish over the cited art, and it is believed that all claims are now in condition for allowance. However, Applicants request that the Examiner call the undersigned if anything further is required by the Examiner prior to issuance of a Notice of Allowance for all claims.

No fee is believed due related to the filing of this amendment. However, if any fee is due, the Commissioner is authorized to charge any such fee and any additional fees due or credit any overpayment to Deposit Account No. 50-0951.

Respectfully submitted,



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